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NRL Memorandum Report 1770

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**Study Plan for an Investigation  
of Target Acquisition with  
a Radar-Aided Electro-Optical Missile**  
[Unclassified Title]

H. E. THOMPSON

*Naval Analysis Staff*

February 1967

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NAVAL RESEARCH LABORATORY  
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MEMORANDUM

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SUBJECT: Study Plan for an Investigation of Target Acquisition  
with a Radar Aided Electro-optical Missile

Background:

The Naval Research Laboratory has been engaged in a study program to investigate techniques for missile guidance that are compatible with the use of a high resolution radar in the launch aircraft. Previous work accomplished under this program has dealt with the detection and acquisition of targets from high resolution radar data, an analysis of high resolution radar target location accuracy, and an error analysis of various missile midcourse guidance schemes.

Findings:

This report presents a study plan for investigating the target acquisition capabilities of an electro-optical air-to-surface missile launched in an up-and-over trajectory. It is proposed that this investigation make use of a simulation which tests the ability of an operator to acquire targets from a TV display. The variables to be incorporated in the study include type of briefing, search initiation altitude, missile velocity, and missile offset.

R&D Implications:

One drawback associated with launching an electro-optical missile in an up-and-over trajectory solely on the basis of visual checkpoint location is the relatively large offset that would result in the terminal phase. Given the precision target location capability associated with a long range synthetic aperture radar, it is possible that this large terminal offset can be considerably reduced thereby increasing to an acceptable level the probability of terminal target acquisition. The simulation study described in this report will attempt to demonstrate whether or not this is the case.

Recommended Action:

The simulation study described herein will be conducted. Its results will be published in a subsequent report.

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~~CONFIDENTIAL~~

**ABSTRACT**

A study plan is described herein for an investigation of the feasibility of employing an up and over trajectory for an electro-optical missile launched with the aid of a synthetic array radar. The study plan proposes that the feasibility of this concept be tested by a simulation experiment which will measure the performance of human operators in detecting and acquiring targets during a simulated mission. The parameters that will be varied are type of reference material, missile velocity, initial missile terminal offset and search initiation altitude.

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## I. INTRODUCTION

The Naval Research Laboratory is currently engaged in an analysis program to investigate advanced ASM guidance and control concepts that would be compatible with the use of a synthetic aperture radar in the launch aircraft. One concept currently being investigated is the use of an up-and-over trajectory for an electro-optical (Condor-type) missile which receives initial launch and/or midcourse guidance from a long range (50 nm) synthetic aperture radar. Consideration of this concept is prompted by the very small launch and guidance errors that would be present when the synthetic array radar is used to locate the target and provide midcourse corrections for the missile. Specific advantages that might accrue from the use of an up-and-over trajectory are:

- a) Such a trajectory maximizes missile range
- b) It provides a longer target area viewing time
- c) It offers the potential for higher missile velocities
- d) It results in maximum missile survivability

This report describes a study plan for one phase of an overall analysis effort being conducted to test the feasibility of this concept.

## II. OBJECTIVES

The study phase dealt with in this report is the last of four phases. The first phase of this overall study was concerned with the human factors problems that relate to the detection and designation of targets from high resolution radar imagery. This study provided data on the types of targets that could be recognized from high resolution radar imagery, how rapidly they could be recognized and how accurately they could be designated for weapon delivery. The results of this study phase are reported in reference 1.

The second phase of this overall study was concerned with an error analysis of the synthetic aperture radar target designation problem in order to determine how accurately a target could be located in aircraft coordinates with this type of radar.

Errors considered in this analysis included radar and navigation system measurement errors, radar resolution errors and operator designation errors. The results of this study phase were reported in reference 2.

A third study phase which is nearing completion is investigating the errors associated with various concepts for pre-launch and/or midcourse missile guidance. The concepts being investigated are briefly described in the next section of this report. It is expected that the results of this analysis will be reported in April 1967.

The final phase of this study, the plan for which is described in this report, deals with a simulation study of the terminal acquisition of targets by a command guided electro-optical missile following an up-and-over trajectory. The parameters for this simulation study are derived from the three previous study phases and cover a range of values that correspond to the various gradations of system sophistication considered in the other three phases. The intent of this study phase is to determine what effect these parameters have on probability and range of terminal acquisition in order to establish a basis for selecting a particular system configuration.

### III. MISSION DESCRIPTION

The mission that will be simulated in this study is illustrated in Figure 1 in plan and elevation views. In this mission the aircraft uses its long range squinted synthetic aperture radar to map the target area from high altitude after having popped up from low altitude or after having navigated to this point at high altitude. The weapons control officer aboard the aircraft views a passing scene presentation of the synthetic array imagery. When he detects the target or target area on the display he stops the display, possibly "zooms" the display, and then operates an electronic cursor to designate the target.

The cursor designation provides the data necessary to locate the target in X-Y coordinates. These coordinates are transferred to the aircraft computer where, along with information provided by the aircraft navigation system, they are used to generate aircraft steering commands. Following steering commands generated by the computer and displayed to the pilot, the aircraft makes a turn toward the target and flies in a straight line to the target until a missile launch position is reached.

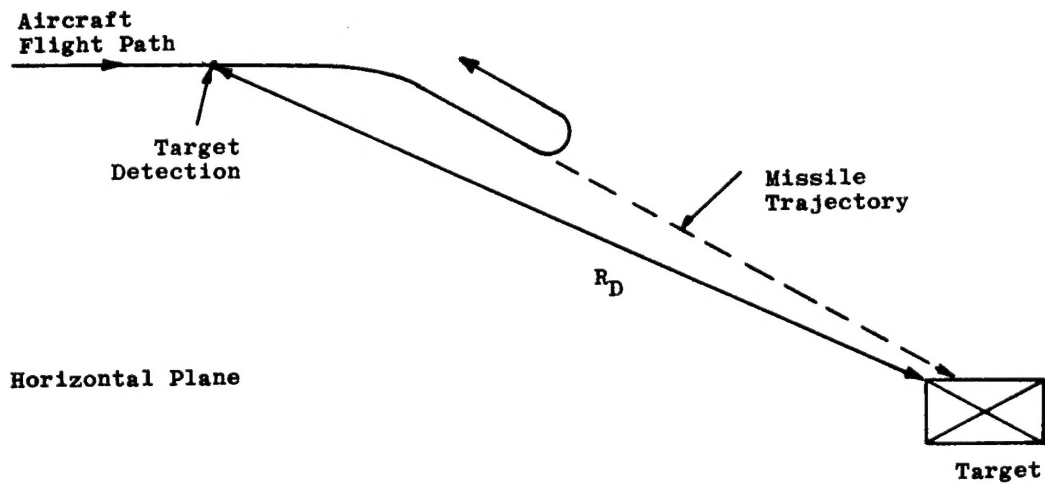
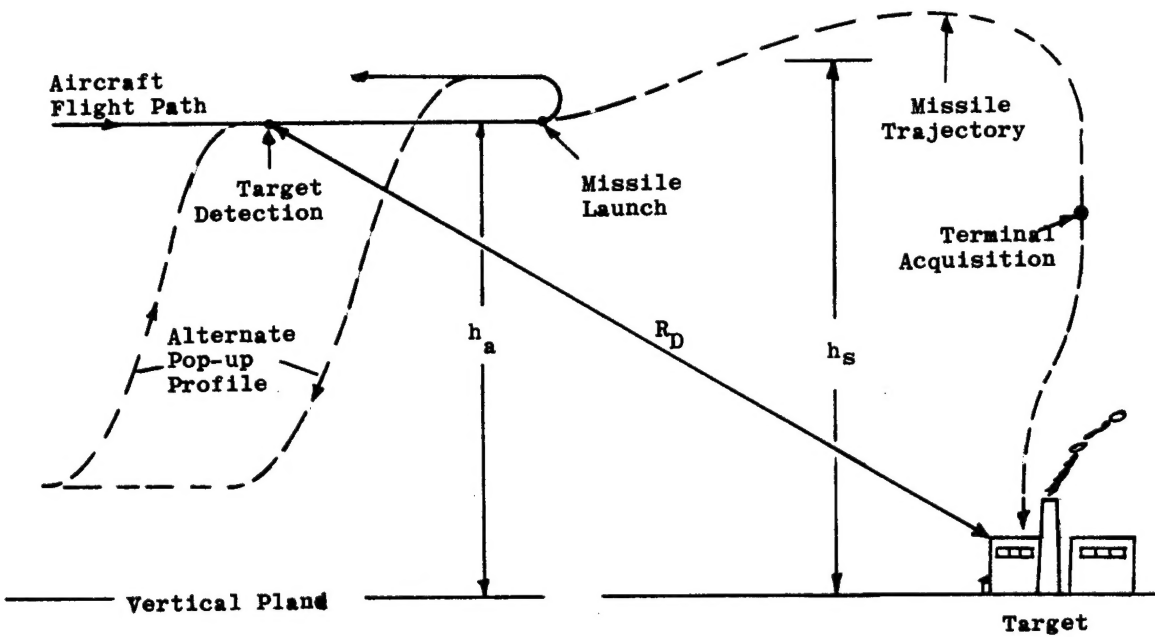


Figure 1 - Mission Profile - Up-and-over Missile Delivery



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When the aircraft reaches a launch position the calculated target coordinates are transferred by the computer into the missile navigation system. The missile is then launched in an up-and-over trajectory, with the target coordinates inserted into the missile navigation system providing the basis for initial midcourse guidance. The aircraft then turns from its flight path and begins to fly away from the launch point in whatever direction maximizes its survivability.

There are several types of subsequent midcourse guidance that might be employed. One type of guidance might be a programmed altitude and heading system which makes use of a navigational reference internal to the missile. Another type of midcourse would be a system which tracks and guides the missile from the aircraft based on remembered target position. This scheme would have the advantage of eliminating the necessity for a possibly expensive navigation system aboard the missile. A somewhat more sophisticated system, which would require a different launch tactic, would involve continuous tracking of the target by the synthetic array radar and the use of the continuously updated target location to guide the missile. In this system the missile data link would be tracked to provide missile location information.

The effect of using different forms of midcourse would be to vary the r.m.s. distance by which the missile is offset from the target at initiation of its terminal phase. In the type of trajectory considered here, the missile would enter its terminal phase at some point within a narrow cone directly above the target. When the missile enters its terminal phase, the weapons control officer aboard the aircraft begins to search the TV picture of the target area relayed back via data link from the missile's TV seeker. If cloud cover is present, the weapons control officer does not view the target area until the missile breaks through the cloud cover. Once the WCO has a TV view of the ground he begins to search for the target. If he is able to detect the target he then designates it to the missile seeker by means of a cursor control device. Once the target is designated, the missile seeker locks on and begins to automatically track the target, providing guidance commands that result in the missile's impacting within some CEP of the target.

#### IV. SIMULATION VARIABLES

In the simulation study, only those parameters which directly affect probability of terminal target acquisition will be varied.

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Those parameters which will not be varied in the simulation but which help to define the mission as illustrated in Figure 1 are as follows:

Radar Detection Range ( $R_D$ ) - 50-60 nm  
Radar Squint Angle ( $\theta$ ) -  $45^\circ$   
Aircraft Altitude ( $h_A$ ) - 30K feet  
Aircraft Velocity ( $V_A$ ) - M 0.9; M 1.6  
Missile Launch Range ( $R_M$ ) - 30-50 nm  
Missile Field of View -  $35.7^\circ$  cone

Those parameters which affect probability of target acquisition and which will be varied in the simulation are listed as follows along with the range of values which they will assume:

<u>Variable</u>	<u>Range</u>
Search Initiation Altitude ( $h_S$ )	10K, 20K, 30K, 40K
Missile Velocity ( $V_M$ )	1,000 fps, 600 fps
Initial Terminal Offset	1500', 3000', 4500'

The search initiation altitude is defined as that missile altitude at which the target area is first imaged by the missile seeker. Initial terminal offset is that distance from a vertical line through the target by which the missile is offset at search initiation altitude. The range of values which the latter variable will take, as given above, is representative of a range of possible synthetic array radar-aided guidance systems.

## V. SIMULATION DESCRIPTION

The mission simulation that will be used in this study is illustrated in the block diagram of Figure 2. As indicated, an aerial photograph of a target area is projected by means of a slide projector on a screen. The slide projector is servoed so that the photo projection can be moved about the screen to simulate the effect of varying the look angle of the missile seeker. This

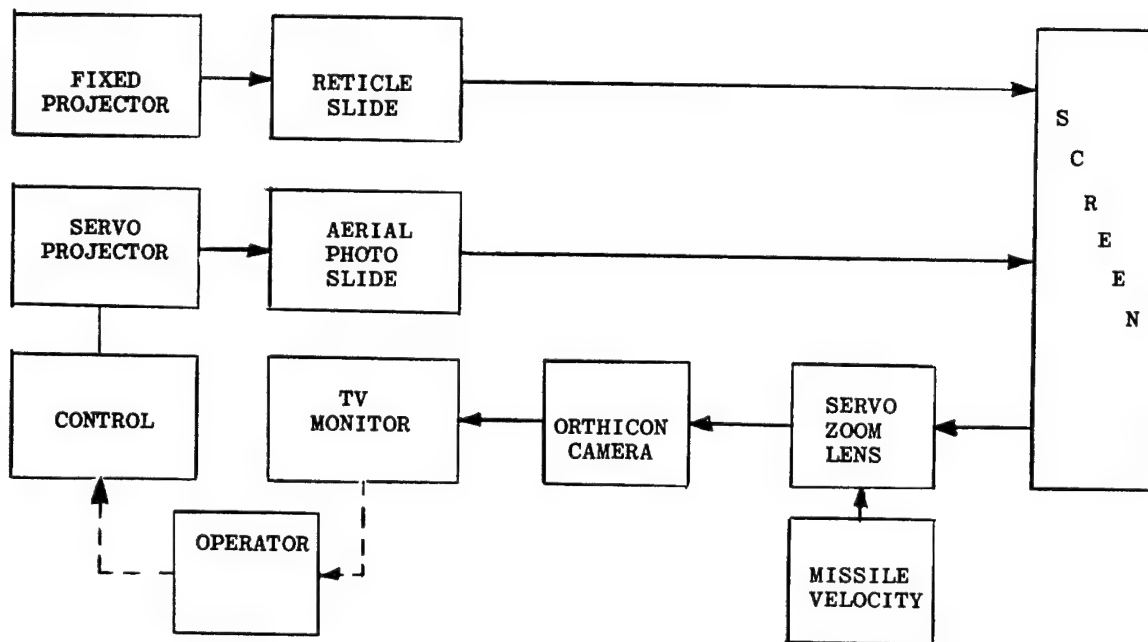


Figure 2 - Block Diagram of Target Acquisition Simulator

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servoed projector is controlled through a "joy stick" mechanism by an operator sitting in a simulated cockpit. Another, non servoed, slide projector is used to project a cursor reticle on the screen. Cursoring of a target is accomplished by the operator's controlling the servoed projector to bring the target under the projected reticle.

Both the projected reticle and photograph are viewed by a TV orthicon chain which transmits a TV image to a monitor mounted in the cockpit and viewed by the operator. At the front end of the orthicon chain is a servoed zoom mechanism which may be programmed to simulate the effect of the missile closing on its target.

Prior to beginning each target acquisition run an initial offset is programmed by prepositioning the projected aerial photograph so that the target will be placed a specified distance from the center of the cursor. An initial search altitude is programmed by pre-zooming the servoed zoom lens to a given magnification setting.

A list of components that make up the simulation along with their salient characteristics is presented in Table 1. Figure 3 presents a photograph of the mock-up cockpit in which the operator sits and performs his target acquisition tasks.

## VI. CLASSIFICATION OF TARGETS

The aerial photos to be used in this simulation are standard Coast and Geodetic Survey photos at a scale of 1:68,000. The photos cover general areas most of which are located in the Mid western U.S. A listing of these areas and a brief description of each are given in Table 2.

Before the simulation could be run it was found necessary to group the targets by order of difficulty. Ideally it would be desirable to have one target against which 18 operators of exactly equal ability could be tested for each of the 18 parameter combinations to be investigated. Since it would not be possible to find 18 equal operators it was decided to do the next best thing and find 18 equal targets.

TABLE 1      SIMULATOR COMPONENTS

<u>Component</u>	<u>Characteristics</u>
Cockpit Mock-Up	See Figure 3
Cockput TV Monitor (CONRAC)	8" Display
Servo Projector (LTV 7000)	Full Scale Excursion Time      .060 sec Small Signal Freq. Response    100 cps Slide Positioning Accuracy $\pm 0.1\%$ Slide Positioning                0.3% Repeatability                (full scale)
Zoom Lens (ANGENIEUX Zoom 10x35B)	Equivalent Focal LGTHS        35-350 mm Relative Aperture                f/3.8-f/22 Max. Angular Field               Diagonal 62°-70° Horizontal 45°-50° Light Transmission               72% Object Distance (Measured from front glass) 0.95 mm
Orthicon Camera (MTI, Model 1400)	Maximum Horizontal Resolution 800 lines Maximum Vertical Resolution    525 lines
TV Monitor (CONRAC)	14" Display
Brush Recorder (REEVES) (Model RE400-1)	Gain Settings                    .05V/mm to 10V/mm Scale                              40 mm to the edge
Timer (STANDARD)	Accuracy $\pm .5$ sec Range                              1000 sec
Analog Computer (Servo and Required Circuitry)	

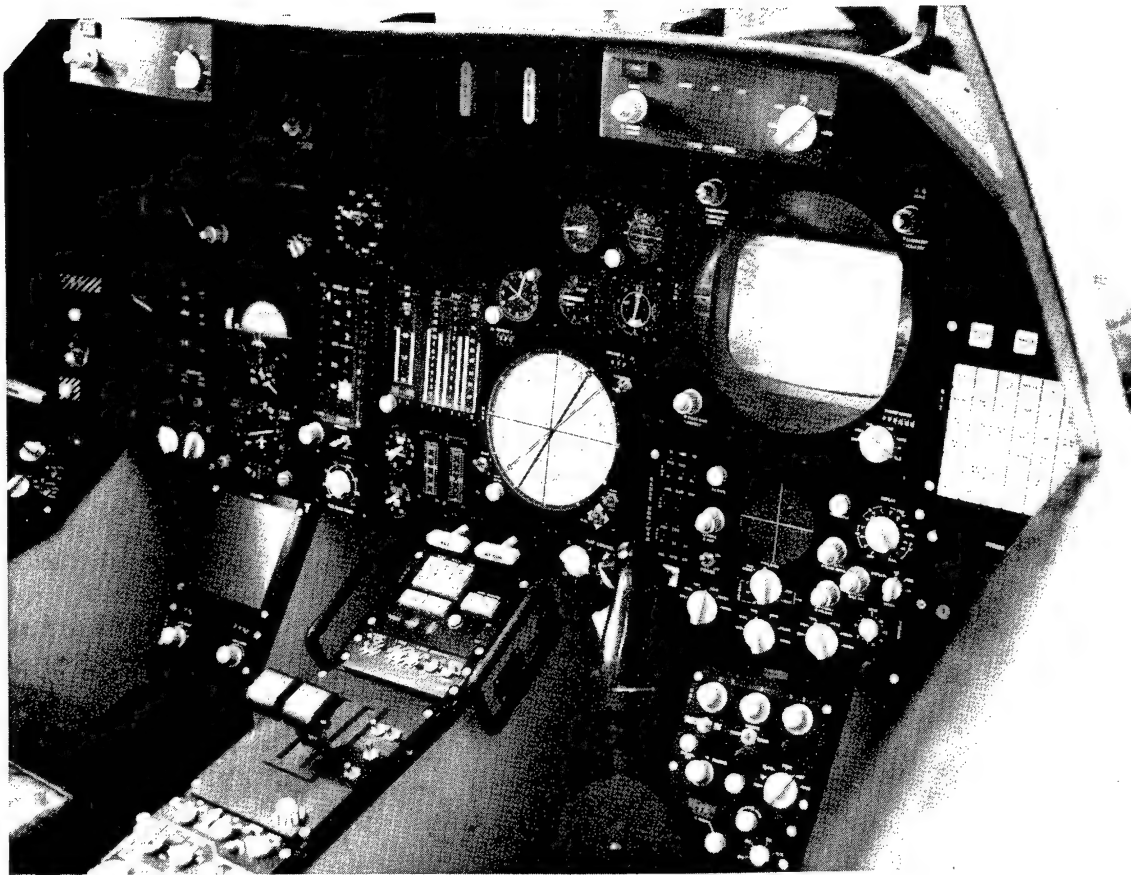


Figure 3 - Cockpit Mockup

TABLE 2 - DESCRIPTION OF TARGET AREAS

<u>Target Area</u>	<u>Description</u>
1. #2631 Newton, Kansas	Built-up area
2. #2683 Newton, Kansas (Outskirts of Newton)	Farm land, sparsely populated level terrain
3. #2284 Kingman, Kansas (Outskirts of Kingman)	Sparsely populated, level terrain with a few ridges and ravines
4. #2204 Isabell, Kansas	Very small town along r.r. partially mountainous to south & northeast of Isabell, level farm land directly north, sparsely populated
5. #2152 Medicine Lodge, Kansas	Medicine Lodge and west of Medicine Lodge along river, r.r. and hwy. lying between mountain range, sparsely populated
6. #218 Pittsburgh	Rolling hills outside of Pittsburgh, densely populated
7. #4862 Guymon, Oklahoma	Metropolitan and surrounding area, level terrain
8. #2611 Valmora, N.M.	Mountainous area, rugged terrain
9. Washington, D.C.	Metropolitan area, large city, very densely populated, many man made targets

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Accordingly, a total of 83 targets were selected from the 9 areas described above and were tested by a group of 4 operators. In these initial simulation runs each target was viewed by each operator under the same initial conditions - a simulated search initiation altitude of 30,000 feet, an initial offset of 4500 feet, and a missile velocity of 600 ft/sec. From these runs a "normalized" average time at which the targets were identified was obtained and subsequently used for classification of the targets. Targets for which the identification time was  $\leq 18$  seconds were classified as easily identified targets; those for which the identification time lay between 20 and 24 seconds were classified as medium difficulty targets; and those for which the identification time was  $\geq 26$  seconds were classified as hard-to-identify targets. Targets for which the identification time of the individual operators had a wide spectrum of values were not included in any of the above classifications.

By this procedure a total of 54 targets divided into groups of 18 each were selected for further experimentation.

## VII. BRIEFING PHILOSOPHY

Prior to beginning simulation runs all operator's were given an orientation briefing to acquaint the test subjects with the purpose of the simulation and to describe what was expected of them. The briefing charts used in this orientation appear at the end of this report as Appendix A.

In addition to the orientation briefing, each subject will be briefed prior to each of his simulation runs. The reference material used in this briefing will consist of:

1. aerial photographs \*
2. maps of the area (scale = 1:200,000)
3. a target description outline

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\* It is hoped that in a follow-on phase, the availability of high resolution radar data in conjunction with aerial photographs will permit briefing with this radar data. This is more representative of the actual VFAX/MMR situation.



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The operators will be given a set of nine aerial photographs and accompanying maps of the areas simulated. The operators will be allowed as much time as necessary to familiarize themselves with the target areas. The operators will then be given a description of the mission simulated, the parameters of interest, the simulation ground rules and the objective of the simulation. The subject will be told that his performance depends on the speed and accuracy with which the target can be identified.

Just prior to the simulation run, the operator will be given an aerial photograph of the target area with the target designated. The orientation of the target area as well as an indication of the area on the photograph lying within the missile's field-of-view will be furnished the operator. A verbal and written description of the target desired will be presented to the operator. During the simulation run the operator will have access to the accompanying aerial photographs.

In a second experiment, briefing by the use of reference maps only will be investigated. No aerial photographs will be furnished the operator. The targets will be designated on the maps and described verbally. An indication of target orientation and the area on the map lying within the missile's field-of-view will be furnished the operator. The operator will have access to the maps during the simulation run.

#### VIII. DATA COLLECTION AND REDUCTION

The data that will be obtained from the simulation will include continuous brush recordings of the following quantities:

- Time from search initiation
- Missile altitude
- Missile position in X coordinate
- Missile position in Y coordinate
- Missile offset from target in X direction
- Missile offset from target in Y direction

The accuracies with which these quantities can be recorded are as follows:

- Time  $\pm .1$  sec
- Altitude  $\pm 1.25\%$
- X & Y position  $\pm 2.5\%$
- X & Y offset  $\pm .25\%$

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A statistical analysis of missile offset as a function of time will be performed to determine that offset at which target recognition is indicated. Once a criterion for target recognition has been established all simulation runs will be examined to determine an elapsed time for recognition. In those runs where the offset for recognition is not achieved, or where it is achieved but later exceeded, it will be assumed that the target has not been recognized.

The performance parameters that will be reduced from the raw data are time to recognize, recognition range, missile offset and probability of recognition. Curves will then be drawn up relating these performance parameters to the mission parameters varied during the simulation - initial altitude, initial offset, missile velocity, and type of briefing. These curves will then be used to discover the trends that relate operator performance to the variables that affect operator performance.

#### IX. SCHEDULE OF RUNS

A listing of the simulation runs that will be made is given in Table 5 in terms of the targets that will be used and the initial parameters for each run. It is intended that each operator will complete all 54 runs listed in Table 3. A total of 6 operators will be used - 3 for each briefing case.

It is expected that all simulation runs can be completed by March 1967. A report of the results obtained will be available by April 1967.

TABLE 3 - LIST OF SIMULATION RUNS

RUN NO.	TARGET AREA	TARGET NO.	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
1	Washington, D.C.	19	10	4500	1000	Right corner of large building @ Quarters "K"
2	Valmora, New Mexico	9	10	3000	1000	Hwy bridge crossing Wolf Creek @ Valmora
3	Newton, Kansas	79	10	4500	1000	Bridge crossing Sand Creek, SW Newton
4	Pittsburgh, Penn.	25	10	1500	1000	Intersection of Pa. Turnpike & Rt. 22 @ Pitts. interchange
5	Kingman, Kansas	5	10	1500	1000	Ranch where AT&SF crosses south fork of Ninnescah river west of Kingman
6	Newton, Kansas	18	10	4500	1000	RR Bridge crossing Sand Creek between marshalling yard & Newton
7	Newton, Kansas	26	10	1500	1000	RR cars in marshalling yard @ Newton
8	Kingman, Kansas	54	10	3000	1000	Hwy bridge over RR (below Tgt. 24)
9	Washington, D.C.	60	10	3000	1000	Building (white) along the west side of Pentagon

TABLE 3 - SIMULATION RUNS - CONTINUED

RUN NO.	TARGET AREA	TARGET NO.	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
10	Valmora, New Mexico	86	10	4500	600	Building in Valmora
11	Newton, Kansas	53	10	3000	600	Building complex along road,
12	Washington, D.C.	28	10	1500	600	Shirley Hwy overpass between Quarters "K" and Pentagon
13	Newton, Kansas	23	10	4500	600	West end of the northern support for the hwy 81 & 15 bridge crossing Vester Creek south of Newton
14	Valmora, New Mexico	22	10	1500	600	AT&SF crossing Wolf Creek
15	Guymon, Oklahoma	85	10	3000	600	South point of racing oval (black spot)
16	Washington, D.C.	105	10	3000	600	Connecting tunnel for east wing of Navy Annex Building
17	Pittsburgh, Penn.	84	10	1500	600	Road entrance to Motel
18	Newton, Kansas	106	10	4500	600	Building @ end of short road

TABLE 3 - SIMULATION RUNS - CONTINUED

RUNS NO.	TARGET AREA	TARGET NO.	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
19	Washington, D.C.	51	20	4500	1000	Theater in south post of Ft. Meyer
20	Newton, Kansas	97	20	4500	1000	NE corner of housing development, road entrance
21	Kingman, Kansas	72	20	3000	1000	Ninnescah Lake front bridge
22	Medicine Lodge, Kan.	47	20	3000	1000	Hwy bridge crossing Dry Creek east of Medicine Lodge
23	Newton, Kansas	70	20	1500	1000	Middle of three oil tanks
24	Guymon, Oklahoma	15	20	1500	1000	Southern of two buildings along RR east of Guymon
25	Newton, Kansas	13	20	4500	1000	Hwy bridge crossing south fork of Vester Creek south of Newton near merger of two forks of river
26	Medicine Lodge, Kan.	74	20	3000	1000	School building west of river, south of creek (black)
27	Washington, D.C.	4	20	1500	1000	Center of Pentagon

TABLE 3 - SIMULATION RUNS - CONTINUED

RUNS NO.	TARGET AREA	TARGET NO.	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
28	Kingman, Kansas	99	20	1500	600	Building by 5 sided white plot
29	Medicine Lodge, Kan.	119	20	1500	600	Center wing of plant west of Medicine Lodge
30	Newton, Kansas	61	20	3000	600	Turn-around building @ intersection of 2 RR @ city line Newton
31	Newton, Kansas	43	20	4500	600	Termination of road into north section of circular building
32	Sawyer, Kansas	10	20	4500	600	Ranch 1 mile east of Sawyer between Rt 22 & AT&SF, SW corner of complex
33	Medicine Lodge, Kan.	27	20	4500	600	Hwy bridge crossing Medicine Lodge river parallel to Rt. 166
34	Guymon, Oklahoma	121	20	3000	600	Gas well (black spot)
35	Guymon, Oklahoma	103	20	3000	600	Building within dark circle
36	Washington, D.C.	69	20	1500	600	Pentagon road entrance

TABLE 3 - SIMULATION RUNS - CONTINUED

RUN NO.	TARGET AREA	TARGET NO.	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
37	Isabell, Kansas	82	30	1500	1000	Building complex SE of Isabell
38	Newton, Kansas	115	30	4500	1000	Connecting point of circular road @ Newton
39	Pittsburgh, Penn.	120	30	4500	1000	River crossing Rt. 22 east of Pitts. interchange in metro. area
40	Newton, Kansas	17	30	3000	1000	Missouri Pacific RR bridge crossing Sand Creek north of Newton
41	Isabell, Kansas	6	30	3000	1000	South point of major intersection (triangular) east of Sawyer
42	Guymon, Oklahoma	49	30	1500	1000	South point of intersection of Rts. 54, 81 & 3
43	Pittsburgh, Penn.	12	30	3000	1000	Center of bridge crossing Pa. turnpike east of Pitcairn
44	Washington, D.C.	96	30	1500	1000	Building @ National Airport north of terminal (black)
45	Kingman, Kansas	3	30	4500	1000	Intersection of Hwy & Missouri Pacific RR @ Brown's Spur west of Kingman

TABLE 3 - SIMULATION RUNS - CONTINUED

RUN NO.	TARGET AREA	TARGET NO	INITIAL ALTITUDE K FEET	INITIAL OFFSET FEET	MISSILE VELOCITY FT/SEC	TARGET DESCRIPTION
46	Isabell, Kansas	118	30	4500	600	Road from building along RR (sharp bend)
47	Washington D.C.	123	30	1500	600	Penthouse on right wing of apartment building
48	Medicine Lodge, Kan.	20	30	1500	600	Hwy 160 bridge crossing Medicine Lodge
49	Guymon, Oklahoma	31	30	3000	600	Center of middle wing of Carbon Black Plant
50	Kingman, Kansas	117	30	4500	600	Hwy Bridge crossing ravine SW of Brown's Spur
51	Kingman, Kansas	24	30	4500	600	Bridge crossing river at Ninnescah Lake west of Kingman
52	Newton, Kansas	124	30	3000	600	Hwy bridge over dry creek west of city
53	Isabell, Kansas	109	30	1500	600	Building 3 blocks east of city and 1 block north
54	Kingman, Kansas	126	30	3000	600	Road from small cluster of homes

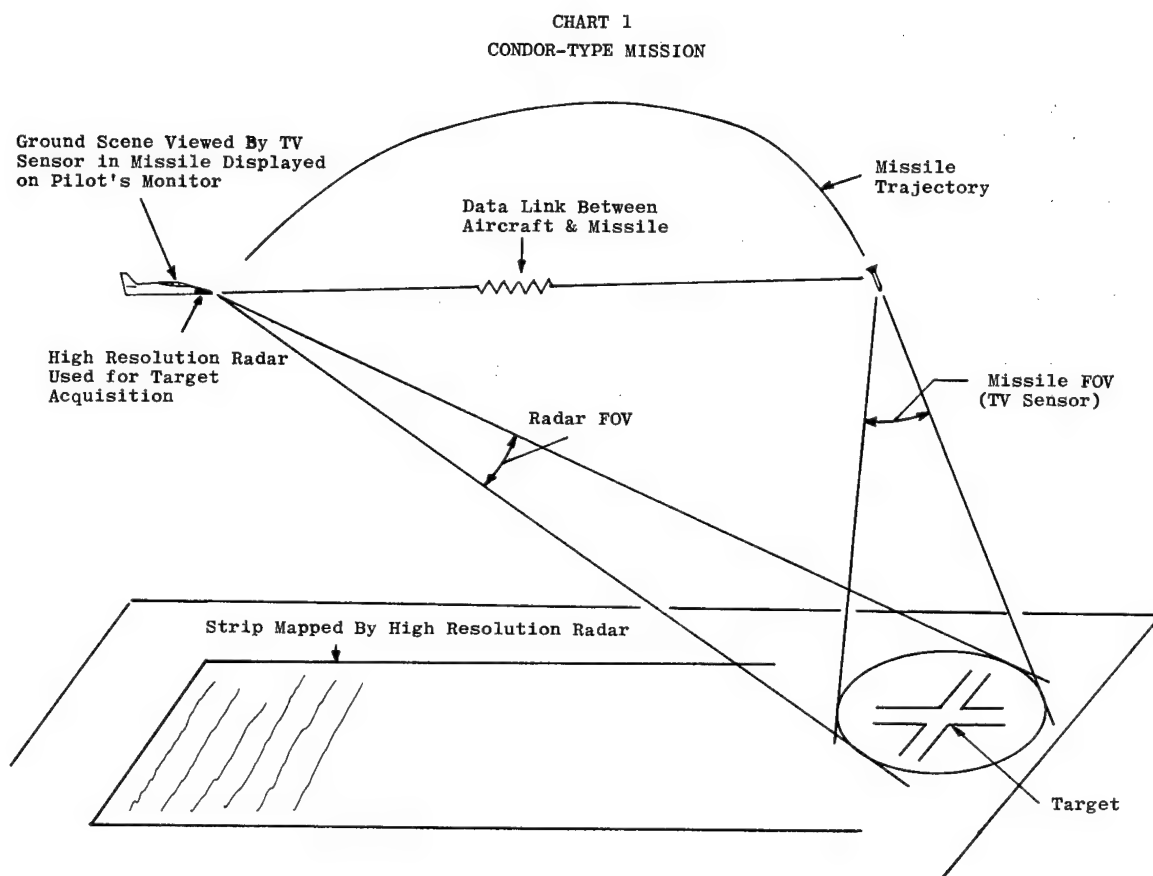




## APPENDIX A

### BRIEFING CHARTS USED IN INITIAL OPERATOR ORIENTATION

The charts contained in this Appendix represent those that were used in the initial orientation briefing that was given to all subjects who ~~were~~ participated in the simulation exercise. The purpose of these charts was to acquaint the subjects with the objectives of the simulation and to define what they were expected to contribute by their participation.



**CHART 2**  
**MISSION PHASES**

- I. Acquisition of Target by Aircraft
- II. Designation of Target by Pilot Missile Launch
- III. Missile Launch
- IV. Missile Follows Up-and-Over Trajectory to Vicinity of Target
- V. TV Sensor in Missile Receives Ground Image Within Camera's FOV; Relays Picture to TV Monitor in Aircraft
- VI. Pilot Searches for Target Within Missile's FOV
- VII. Target Identified, Operator Lays Cursor on Target and Initiates Automatic Tracking of Target by Missile (Lock-on)
- VIII. Missile Automatically Tracks Target to Impact (Pilot has Manual Over Ride Capability)

**CHART 3**  
**ASM SYSTEM CHARACTERISTICS**

1. Target Detection Sensor	=	High Resolution Squinted Radar
2. Target Detection Range	=	50 nm
3. Radar Strip Map Width	=	5-10 nm
4. Missile Sensor	=	Electro-Optical (TV)
5. Missile Sensor Range	=	2-5 nm
6. Missile Sensor FOV	=	37.5°
7. Missile Terminal Velocity	=	600-1000 ft/sec
8. Expected Midcourse Offset	=	1500-5000 feet

CHART 4  
HIGH ALTITUDE E/O TARGET ACQUISITION SIMULATION

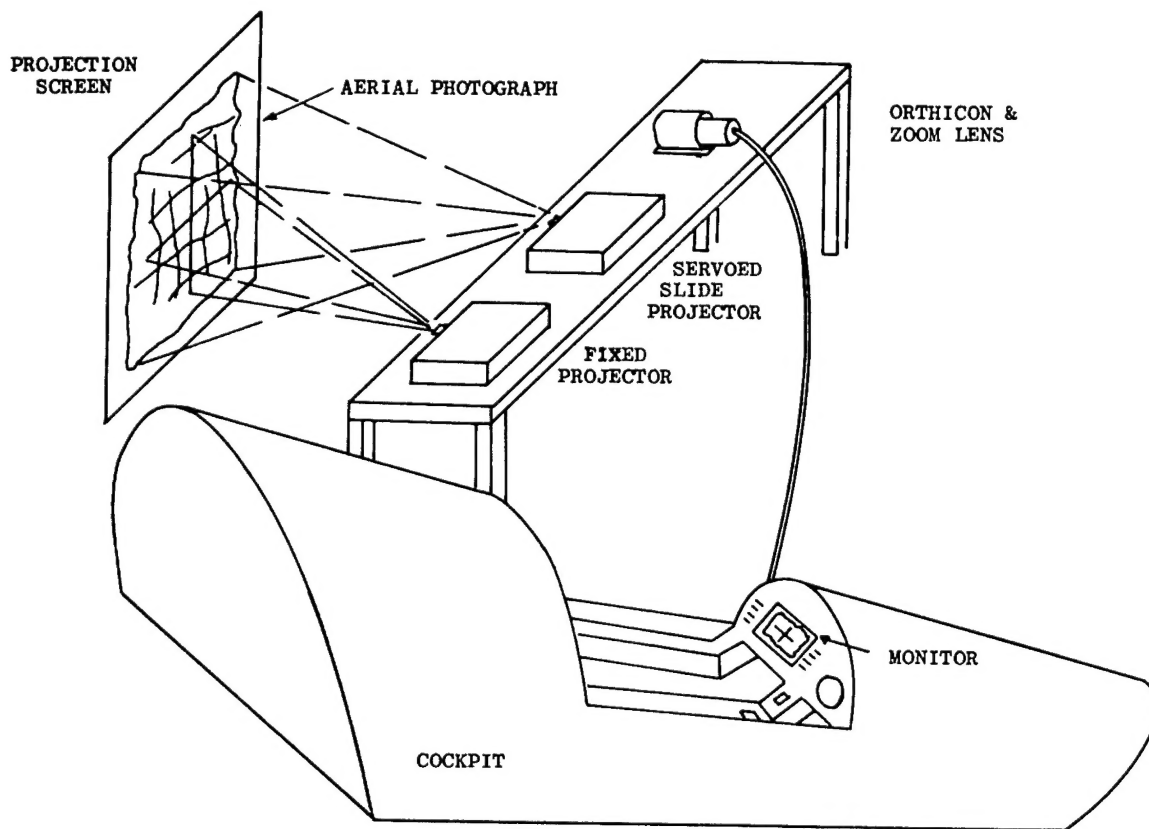
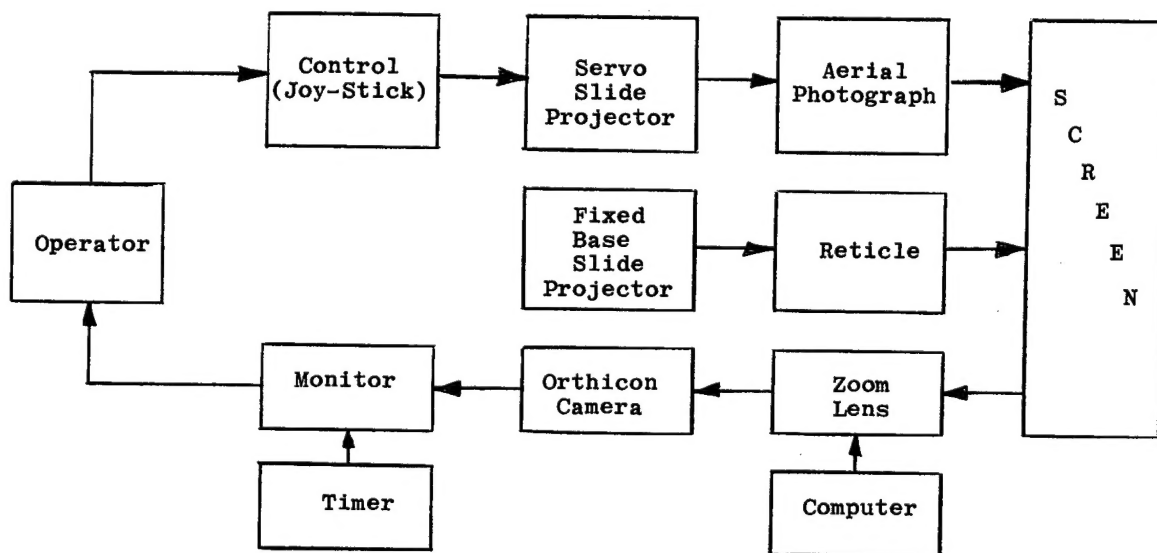


CHART 5  
HIGH ALTITUDE E/O  
TARGET ACQUISITION SIMULATION



**CHART 6**  
**SIMULATION PROCEDURE**

**I. BEFORE START SWITCH IS PUSHED**

Picture Not On Monitor  
Handle Active  
Offset Adjusted By Pilot On Commands From Operator  
Ready Command Issued By Operator

**II. SIMULATION RUN (PRESS BUTTON ON TOP OF STICK)**

Picture Appears On Monitor  
Pilot Orientation of Picture  
Target Location  
Cross Hair Placement (As Quickly and Accurately as Possible  
with Minimum Oscillation About Target)  
Side Switch Depressed To Mark

**III. AFTER RUN**

Operator Marks Target Location  
Timer Shuts Off Monitor  
Pilot Resets System By Depressing Button On Top Of Switch

**CHART 7**  
**SIMULATION VARIABLES**

Initial Offsets	-	1500'	3000'	4500'
Initial Altitudes	-	10,000'	20,000'	30,000'
Velocities	-	600 ft/sec	1000 ft/sec	